

REMARKS

Claims 1-7, 20-27, 35-38, and 45-56 are pending in the application with claims 1, 20, 21, 36, 45, and 46 amended herein, new claims 51-56 added herein, and claims 8-19, 28-34, and 39-44 canceled herein.

Claims 1-7, 20-27, 35-38, and 45-50 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Raaijmakers. Applicant requests reconsideration.

Amended claim 1 sets forth a dielectric material forming method that includes, among other features, forming a second monolayer on a first monolayer and forming a dielectric layer containing the first and second monolayers. One of the first and second monolayers contains tantalum and oxygen. The other of the first and second monolayers contains zirconium and oxygen. With 2-20% of the dielectric layer being the other of the first and second monolayers, the dielectric layer exhibits a dielectric constant greater than the first monolayer.

Page 2 of the Office Action alleges that Raaijmakers discloses alternating monolayers of different metal oxides and that it would be obvious for those of ordinary skill to perform the claimed method even though each and every limitation of claim 1 is not disclosed in Raaijmakers. Applicant asserts that Raaijmakers fails to disclose or suggest 2-20% of the dielectric layer being the other of the first and second monolayers containing zirconium and oxygen. Also, Raaijmakers fails to disclose or suggest the dielectric layer exhibiting a dielectric constant greater than the first monolayer.

The Office Action relies upon [0123-0124] of Raaijmakers for its description of a stack of distinct dielectric sublayers containing alternating layers of Ta_2O_5 and TiO_2 and upon other portions of Raaijmakers allegedly describing ZrO_2 as a suitable alternative for TiO_2 . However, regardless of the alleged disclosure in Raaijmakers, such reference

fails to disclose or suggest the advantage of combining a first monolayer and a second monolayer into a dielectric layer that exhibits a dielectric constant greater than the first monolayer. Specifically, Raaijmakers fails to disclose or suggest 2-20% of the dielectric layer being a monolayer containing zirconium and oxygen. Raaijmakers [0123-0126] merely describes equal proportions of Ta_2O_5 and TiO_2 .

In contrast, [0024] and [0033] of the present specification uniquely recognize that doping tantalum oxide containing dielectric materials with certain metal oxides during formation by ALD can significantly enhance the dielectric constant and decrease leakage current. Zirconium oxide can used to enhance dielectric constant as well as reduce leakage current. Chemisorbing small amounts of material and/or forming materials one monolayer at a time allows precise control of doping. Also, [0035] of the present specification provides an exemplary composition range of from about 2% to about 20% of the monolayers being monolayers containing zirconium and oxygen.

Reference to [0105] and [0108] reveals that Raaijmakers describes a dielectric constant of 20-25 for Ta_2O_5 and a dielectric constant of 18-24 for ZrO_2 . Thus, pursuant to the teachings of Raaijmakers, those of ordinary skill would expect that adding ZrO_2 to Ta_2O_5 reduces dielectric constant instead of increasing it simply because ZrO_2 has a slightly lower range of dielectric constant. Such teaching in the art is in contrast to the observation recorded in the present specification of significantly enhancing dielectric constant with metal oxide doping of tantalum oxide.

Not only does Raaijmakers fail to appreciate the advantage of combining different metal oxides to enhance the dielectric constant, such reference also fails to appreciate the optimal compositional range within which dielectric constant enhancement occurs best. Accordingly, regardless of whether Raaijmakers discloses

or suggests combining Ta₂O₅ and ZrO₂, such reference cannot be considered to disclose or suggest the compositional range set forth in claim 1 and the advantages achieved by such composition. At least for such reason, Raaijmakers fails to disclose or suggest every limitation of amended claim 1.

Claims 2-7 and 51 depend from claim 1 and are patentable at least for such reason as well as for the additional limitations of such claims not disclosed or suggested. For example, claim 6 sets forth that forming of the dielectric layer includes annealing. In the present specification, [0038] sets forth that annealing is one example of additional processing that can advantageously distribute components originally formed as a discrete layer throughout a composite dielectric material such that substantial homogeneity is achieved. Applicant acknowledges a discussion in [0099] and [0105] of Raaijmakers regarding annealing amorphous TaO₂ dielectric layers. However, such annealing only occurs when a crystallized dielectric is desired. Accordingly, Applicant asserts that Raaijmakers does not disclose annealing a dielectric material having the monolayers and composition set forth in claim 1. Also, claim 51 sets forth that 5-15% of the dielectric layer is the other of the first and second monolayers containing zirconium and oxygen. Since Raaijmakers fails to appreciate the advantages of metal oxide doping of tantalum oxide dielectric, such reference fails to disclose or suggest the compositional range set forth in claim 51.

Amended claim 20 sets forth a dielectric material forming method that includes, among other features, chemisorbing alternated monolayers of a first dielectric material and a second dielectric material over a substrate and providing fewer monolayers of the second material compared to the first material. The first material contains tantalum and oxygen and the second material contains zirconium and oxygen with 2-20% of the

monolayers being monolayers of the second material. As discussed above with regard to the deficiencies of Raaijmakers as applied to claim 1, such reference fails to disclose or suggest 2-20% of the monolayers being monolayers of the second material containing zirconium and oxygen, as set forth in claim 20. At least for such reason, Raaijmakers fails to disclose or suggest every limitation of claim 20.

Claims 21-27 depend from claim 20 and are patentable over Raaijmakers at least for such reason as well as for the additional limitations of such claims not disclosed or suggested. For example, claim 21 sets forth that from about 5% to about 15% of the monolayers are second material monolayers. Also, claim 27 sets forth that the method of claim 20 further includes annealing the monolayers. As will be appreciated from the above discussion regarding the deficiencies of Raaijmakers as applied to respective claims 51 and 6, such reference fails to disclose or suggest the subject matter of claims 21 and 27.

Claim 35 sets forth a dielectric material forming method that includes ALD of a plurality of monolayers, each of the plurality of monolayers containing both zirconium oxide and tantalum oxide, and forming a dielectric material. The dielectric material exhibits a dielectric constant greater than that of tantalum oxide. Review of Raaijmakers reveals that such reference fails to disclose or suggest a monolayer or plurality of monolayers each containing both zirconium oxide and tantalum oxide. Raaijmakers also fails to disclose or suggest a dielectric material containing such monolayers exhibiting a dielectric constant greater than that of tantalum oxide.

None of the paragraphs relied upon in the Office Action or those paragraphs associated with Figs. 5 and 6, describing various reaction chemistries, disclose or suggest a monolayer of mixed metal oxide composition. At least for such reason,

Raaijmakers fails to disclose or suggest every limitation of claim 35. In addition, as will be appreciated from the above discussion regarding the deficiencies of Raaijmakers as applied to claim 1, such reference fails to disclose or suggest combining zirconium oxide and tantalum oxide to enhance the dielectric constant of tantalum oxide.

Amended claim 36 sets forth a dielectric layer that includes, among other features, a first monolayer containing tantalum and oxygen and a second monolayer containing zirconium and oxygen with 2-20% of the dielectric layer being the second monolayer. The dielectric layer exhibits a dielectric constant greater than the first monolayer. As may be appreciated from the above discussion regarding the deficiencies of Raaijmakers as applied to claim 1, such reference fails to disclose or suggest 2-20% of the dielectric layer being the second monolayer containing zirconium and oxygen as well as the dielectric layer exhibiting a dielectric constant greater than the first monolayer containing tantalum and oxygen. Claims 37, 38 and 52 depend from claim 36 and are patentable at least for such reason as well as for the additional limitations of such claims not disclosed or suggested.

Amended claim 45 sets forth an enhanced dielectric material that includes, among other features, alternated chemisorbed monolayers of a first dielectric material and a second dielectric material over a substrate. The enhanced dielectric material contains fewer monolayers of the second material compared to the first material with 2-20% of the monolayers being monolayers of the second material. The first material contains tantalum and oxygen and the second material contains zirconium and oxygen. As may be appreciated from the above discussion regarding the deficiencies of Raaijmakers as applied to claim 20, such reference fails to disclose or suggest 2-20% of the monolayers being monolayers of the second material containing zirconium and

oxygen. Claims 46-50 depend from claim 45 and are patentable at least for such reason as well as for the additional limitations of such claims not disclosed or suggested.

Applicant asserts the claim 1-7, 20-27, 35-38, and 45-50 are patentable over Rainmakers and requests allowance of such claims in the Office Action.

Applicant herein adds new claims 53-56 and asserts that at least [0035] of the present specification supports the entire subject matter of such claims.

Applicant herein establishes adequate reasons supporting allowance of claims 1-7, 20-27, 35-38, and 45-56 and requests allowance of all such pending claims in the next Office Action.

Along with a response to the Sept. 3, 2003 Office Action filed on Dec. 3, 2003, Applicant previously provided a copy of a Form PTO-1449 originally submitted on Nov. 29, 2001 along with a copy of a reference apparently missing from the Office's file. The subject reference is authored by Gan et al and listed as reference AS on the Form PTO-1449. Applicant requests consideration of the reference and return of the Form PTO-1449 with the next Office Action including examiner initials indicating consideration of the reference.

Respectfully submitted,

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By:



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